
Fibre Remote IPE product description

This chapter describes Fibre Remote Intelligent Peripheral Equipment (IPE), its architecture, and its hardware options.

It also describes how to plan and engineer a fibre-optic link.

CAUTION

Use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

WARNING

When working with fibre-optic cables, you must adhere to standard precautions used for optical fibres. Before you can handle optical fibres, you must take necessary training and become certified in working with fibre-optic cables.

System overview

Meridian 1 is a Private Branch Exchange (PBX) that links local subscribers to private and public networks and provides a large number of functions and features.

In addition to supporting local subscribers, Meridian 1 can be configured using Remote IPE modules or small cabinets as a distributed system that supports remote subscribers. They are connected to the PBX at long distances using fibre-optic links.

Subscriber connections at local Meridian 1 IPE Modules are the same as the Remote IPE Modules or small cabinet. The subscriber functions and features at the Meridian 1 are also the same as for the Remote IPE site.

This document focuses on the Meridian 1 PBX and Remote IPE equipment specifically designed to provide fibre-optic links between the network functions in Meridian 1 and the peripheral controller functions in the Remote IPE.

System description

The Fibre Remote IPE provides Meridian 1 functionality with the installation of only IPE Modules and IPE cards at a distant site. The Remote IPE shares Meridian 1 common and network equipment to provide the same functions and features to remote subscribers that are available to local Meridian 1 subscribers.

To explain the implementation of Fibre Remote IPE functions, we will describe:

- Fibre Remote IPE physical architecture
- Fibre Remote IPE functional architecture

Fibre Remote IPE physical architecture

To configure a Meridian 1 system with Fibre Remote IPE, you can install a floor-standing column or wall-mounted cabinet at a remote site and connect it using fibre-optic links to an existing Meridian 1 system.

New equipment specifically designed to support the fibre-optics interface consists of:

- an NT1P61 Fibre Superloop Network card, which is housed in a Meridian 1 network card slot
- an NT1P62 Fibre Peripheral Controller card, which is housed in the Remote IPE module or cabinet
- NT1P63 Electro-optical interface packlets, installed onto the Fibre Superloop Network card and the Fibre Peripheral Controller card to provide a fibre-optic link between Meridian 1 and Remote IPE

- an optional NT1P63 Electro-optical interface packet at each site to provide a redundant fibre-optic link
- an NT1P70 wall-mounted cabinet for the remote site
- NT1P75AA fibre-optic patchcords, one for each Electro-optical packet
- NT1P79AA fibre-optic cable between the fibre management frame and the Fibre Peripheral Controller in the wall-mounted cabinet and the floor-standing column
- NT1P76AA cable connecting the Fibre Superloop Network card to the I/O panel and providing Serial Data Interface (SDI) and system monitor ports
- NT1P78AA cable connecting the Fibre Peripheral Controller card to the I/O panel and providing TTY and system monitor ports

Figure 1 illustrates Meridian 1 and Remote IPE equipment linked with fibre-optic cables. The only equipment specifically designed to support this configuration are the cards and the cabinet listed above. All the other equipment is pre-release 20 Meridian 1 hardware.

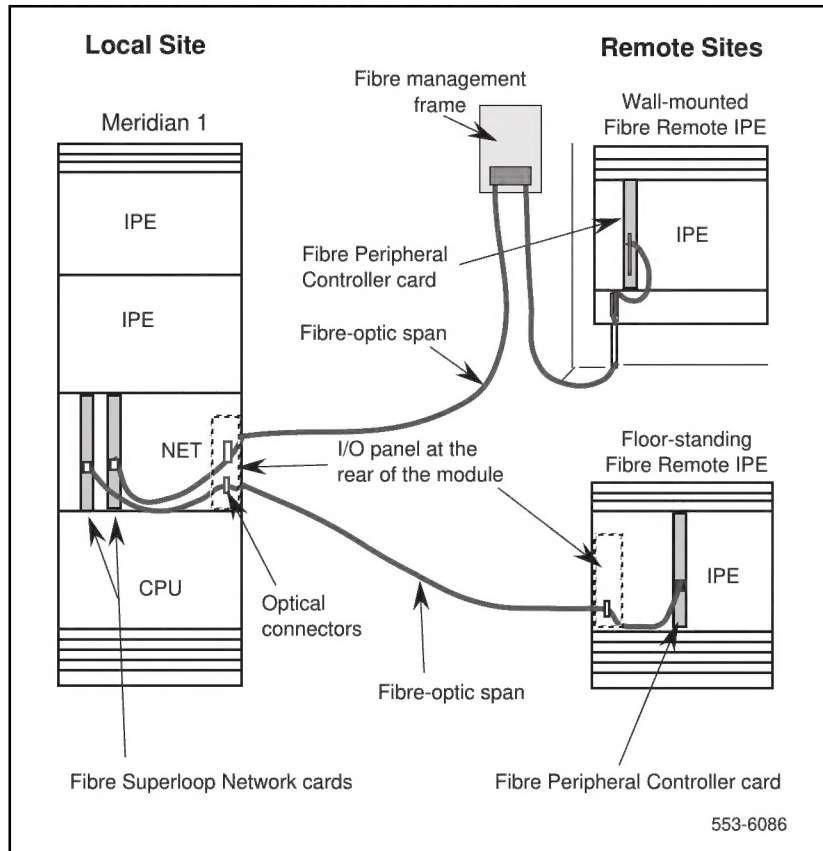
At the local site, fibre-optic cables contain fibre-optic connectors mounted on the I/O panel connector slots at the rear of the Meridian 1 network module. At the remote site, fibre-optic cable connectors are also installed on the I/O panel connector slots at the rear of the floor-standing Remote IPE module. For the wall-mounted Remote IPE cabinet, the fibre-optic link cable from the fibre management frame is connected directly to the FC/PC fibre-optic connectors of the Electro-optical packets located on the Fibre Peripheral Controller card.

Subscriber loops at the Remote IPE are connected to 50-pin connectors on the I/O panel at the rear of the module or at the bottom front of the cabinet as in pre-release 19 hardware. For more details about subscriber connections to Meridian 1 and the Remote IPE, refer to *Meridian 1 system installation procedures* (553-3001-210).

You can select one of two options for the Remote IPE enclosure:

- Floor-standing Remote IPE module
- Wall-mounted Remote IPE cabinet

Figure 1
Meridian 1 to Remote IPE fibre-optic links

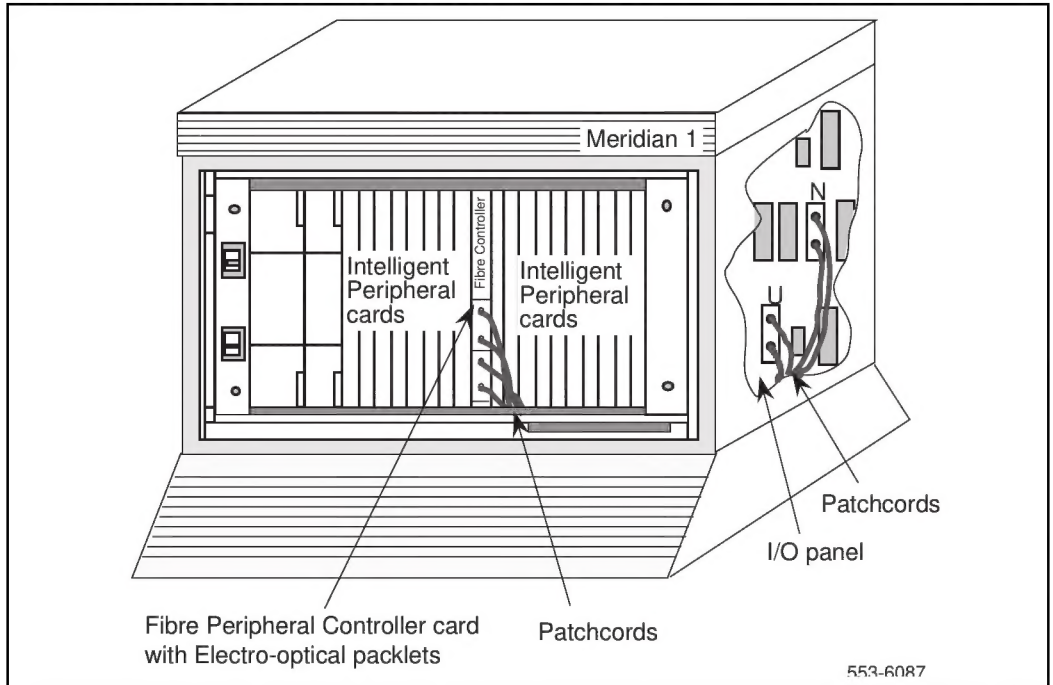


Floor-standing Remote IPE

The floor-standing Remote IPE comprises a pedestal, one or more IPE Modules, and a top cap. The IPE Module houses a maximum of 16 line cards and a Fibre Peripheral Controller card. The communication and signaling between the Meridian 1 central processing unit (CPU) and the Fibre Peripheral Controller card Micro Processing Unit (MPU) is performed over the fibre-optic link. The fibre-optic link also transmits voice and data information originating and terminating at Remote IPE subscriber stations.

Figure 2 illustrates the front view of the floor-standing Remote IPE column with the cross section of the rear of the module showing the I/O panel. The front view shows the location of the Fibre Peripheral Controller card and the fibre-optic cables that connect the fibre-optic interface on the Fibre Peripheral Controller to the optical I/O panel at the rear of the IPE Module.

Figure 2
Floor-standing Fibre Remote IPE column



Wall-mounted Remote IPE cabinet

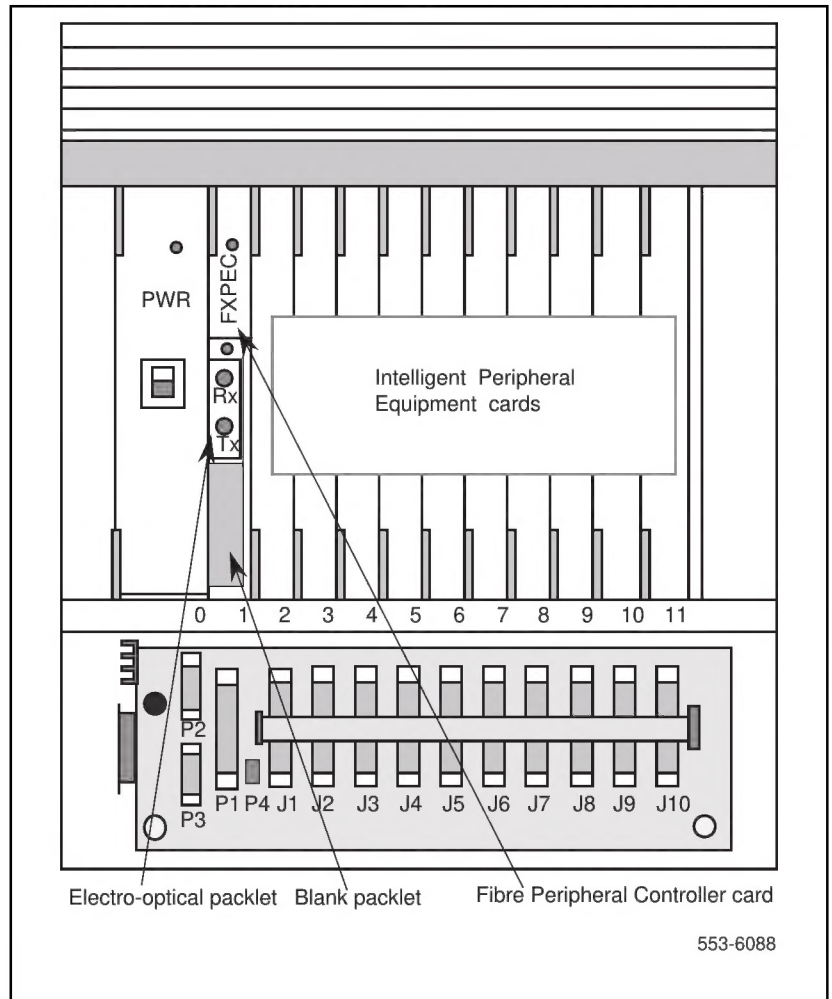
The NT1P70 main wall-mounted Remote IPE cabinet houses a maximum of 10 line cards and a Fibre Peripheral Controller card. The communication and signaling between the Meridian 1 CPU and the Fibre Peripheral Controller card MPU is performed over the fibre-optic link. The fibre-optic link also transmits voice and data information originating and terminating at the Remote IPE subscriber stations.

To expand the number of line cards from 10 to 16, use the first six card slots in the NTAK12 expansion cabinet. Card slots 7 through 12 in the expansion cabinet are not configurable and must not be used. The expansion cabinet is connected to the Fibre Peripheral Controller card housed in the main cabinet with a cable. This allows the Fibre Peripheral Controller card to control the line cards in both cabinets.

Wall-mounted main and expansion cabinets can be AC- or DC-powered. The power source is directly connected to the shelf power supply for the AC-powered system and to the shelf power converter for the DC-powered system.

Figure 3 illustrates the front view of the NT1P70 wall-mounted Remote IPE cabinet. It shows the location of the Fibre Peripheral Controller card and the Electro-optical packlet on the Fibre Peripheral Controller card. A blank packlet is used in the lower packlet position of the Fibre Peripheral Controller faceplate for a nonredundant link configuration in both the floor-standing IPE Module and the wall-mounted cabinet.

Figure 3
Wall-mounted Remote IPE cabinet



Fibre Remote IPE functional architecture

Fibre Remote IPE functions are controlled by the Meridian 1 CPU and the firmware in the Fiber Superloop Network and Fibre Peripheral Controller cards. The CPU uses software instructions to execute call processing, administration, and diagnostic functions. These functions can be divided into three basic categories:

- CPU functions
- Network functions
- IPE functions

Figure 4 illustrates the Meridian 1 functional architecture in a broad block diagram to show the three basic types of functions and system modules supporting these functions.

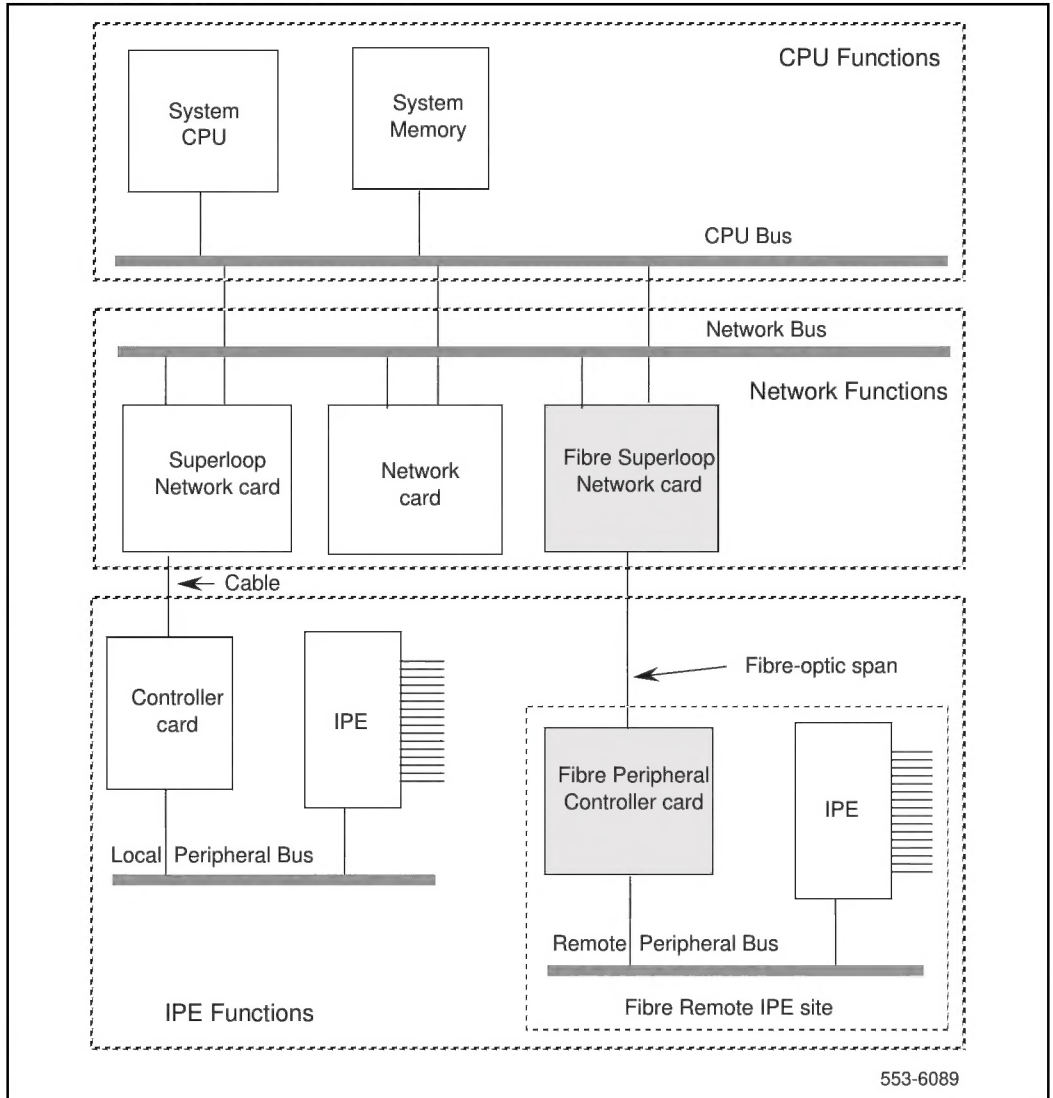
CPU functions

Meridian 1 CPU functions are executed by the system software in the CPU Module normally located at the bottom of the Meridian 1 column. The CPU responds to the interrupt requests from the network equipment and the IPE, and performs the following functions:

- controls call origination, call termination, and feature operation for switched voice and data calls
- executes system administration and configuration functions
- coordinates system diagnostic activities
- controls system utility functions such as software loading, initialization, data dumping, traffic logging, and system auditing

Even though the Remote IPE is removed from Meridian 1, the Meridian 1 CPU controls its functions the same way it controls functions of local IPE Modules.

Figure 4
Meridian 1 functional architecture



Network functions

Network switching functions are executed by the equipment housed in Meridian 1 network card slots. The Fibre Superloop Network card is installed in a network card slot. Through its fibre-optic link, it connects to the Fibre Peripheral Controller card installed in the Remote IPE module or cabinet.

These network functions do the following:

- Perform hardware initialization and self-test upon power up
- Establish call connections between the stations connected to Remote IPE line cards and stations local to Meridian 1 or to trunks for long distance trunk calls over public or private networks
- Communicate switching, peripheral signaling, and maintenance information to and from the CPU and the Peripheral Controller MPU
- Monitor fibre-optic link integrity and transmission quality and provide automatic link switching from the failed primary link to the redundant link
- Provide local and remote loopback testing and fault isolation functions

IPE functions

Intelligent peripheral equipment functions are performed by the Fibre Peripheral Controller card and line cards in the Remote IPE Module or cabinet.

These IPE functions do the following:

- Perform hardware initialization and self-test upon Fibre Peripheral Controller power-up
- Assign time slots to line cards to establish call connections
- Communicate with the Fibre Superloop Network card MPU to provide Remote IPE configuration and maintenance functions

- Monitor fibre-optic link integrity and transmission quality and provide automatic link switching from the failed primary link to the redundant link on the Remote IPE side
- Provide Card-LAN management by polling IPE cards and reporting their status
- Control local stations' ringing functions
- Provide a serial port for local configuration and maintenance functions
- Provide local and remote loopback testing and fault isolation functions

Functional description

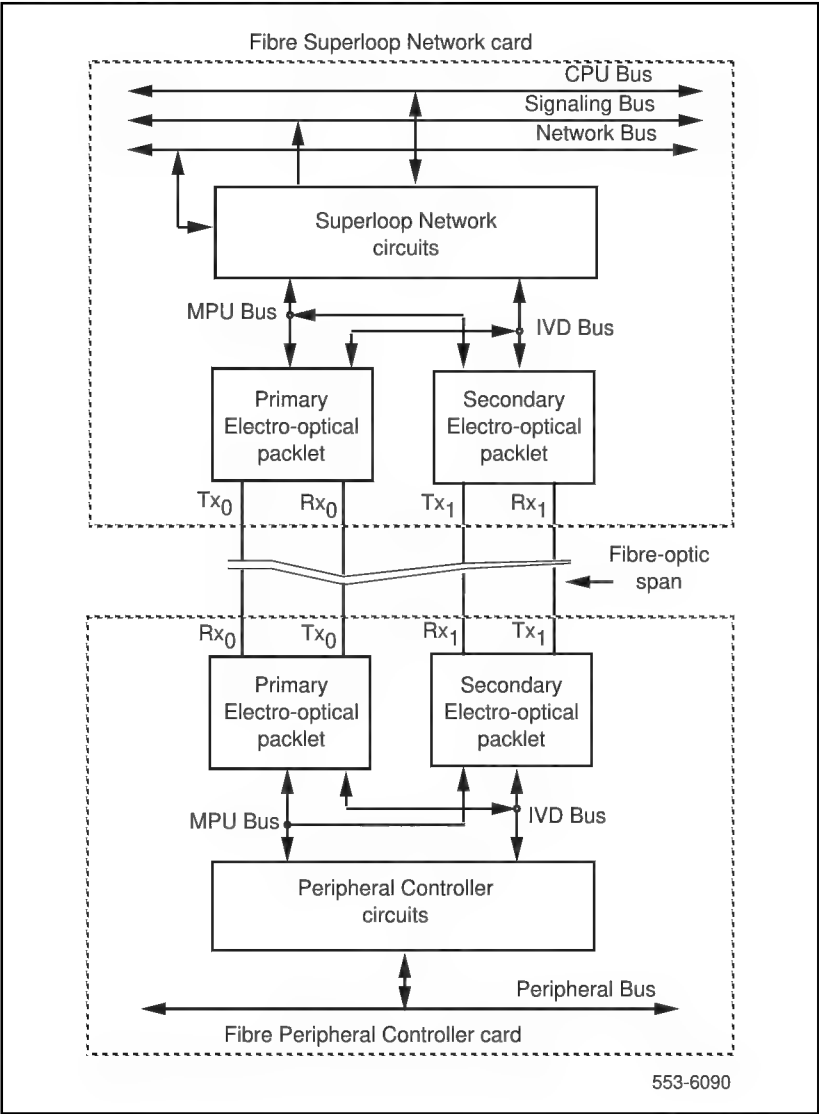
Meridian 1 is controlled by the CPU. The CPU performs read/write functions on the network control and status registers and communicates with the network equipment over the CPU bus. Through these messages, the CPU monitors the system's status, provides call connection sequences, monitors traffic activities, downloads application software and configuration data, and performs system administration and diagnostics.

Fibre Remote IPE utilizes fibre-optic links to provide the same subscriber functionality at the remote site as at the Meridian 1 local site.

Figure 5 illustrates the Meridian 1 Fibre Remote architecture. It shows the Fibre Superloop Network card, the Fibre Peripheral Controller card, and the internal bus structure that connects them to other system components.

Figure 5 also describes the Electro-optical packet to provide an understanding of the internal system communication and call processing activities through the fibre-optic link.

Figure 5
Meridian 1 Fibre Remote architecture



Fibre Superloop Network card

The NT1P61 Fibre Superloop Network card is a microprocessor-controlled network interface between the Meridian 1 CPU and the remote peripheral equipment. To communicate with the CPU, it uses the network, the signaling, and the CPU buses located in the Meridian 1 network module.

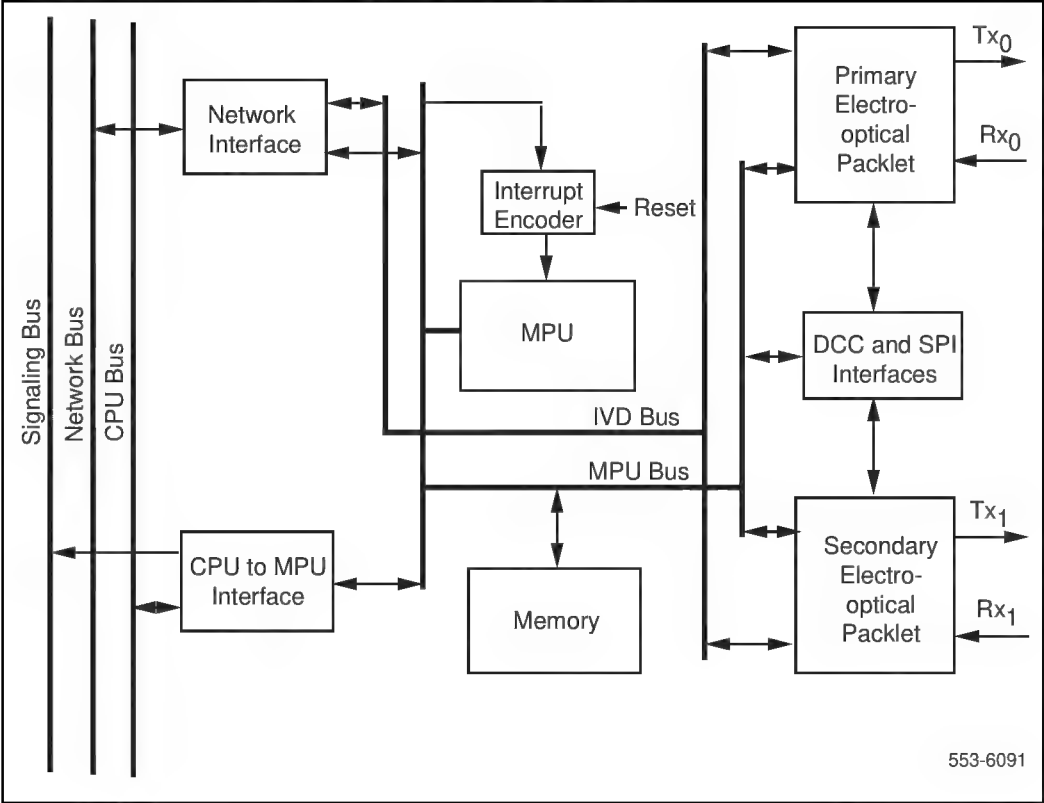
The Fibre Superloop Network card occupies one network card slot and supports four network loops or 128 time slots; 8 for signaling and 120 for voice and data transmission with the Fibre Peripheral Controller card. The Electro-optical packet mounted on the Fibre Superloop Network and Fibre Peripheral Controller cards provide a dedicated link between these two cards.

The main Fibre Superloop Network card performs the following functions:

- Provides a single or a redundant dedicated optical link to connect the Remote IPE to Meridian 1
- Assigns any network time slot to any time slot available on the fibre-optic link to support peripheral equipment time slot assignments
- Supports eight signaling channels for Common Channel Signaling (CCS) in servicing Scan and Signal Distributor (SSD) messages, card maintenance, and card enable messages
- Provides an interface for system power and alarm monitoring
- Provides an interface for a maintenance port
- Provides continuity test pattern generation and detection for loopback testing
- Performs diagnostic self-tests during power-up and when requested by the CPU

Figure 6 shows the Fibre Superloop Network card block diagram illustrating major functional blocks.

Figure 6
Fibre Superloop Network card functional block diagram



Micro Processing Unit (MPU)

The MPU coordinates and controls data transfer and the addressing of peripheral devices and communicates with the Meridian 1 CPU using a message channel on the CPU bus. The tasks the MPU performs depend on the interrupts it receives. These interrupts are prioritized by the importance of the tasks they control.

The MPU is highly integrated and provides most of the decision making logic on the chip. These include controllers, timers, control and arbitration logic, address decoding, dual port RAM and independent direct memory access, parallel input/output ports, and three independent full duplex serial communication channels that support various protocols and a synchronous SPI interface.

The MPU can be reset by:

- powering up the Fibre Superloop Network card
- the watchdog timer
- the ENB/DIS switch
- the Meridian 1 CPU command

Memory

The Fibre Superloop Network memory stores programs and data for the following functions in the following locations:

- Boot code and self-test code are stored in the EPROM.
- Data is stored in the RAM.
- The main function code is stored in the Fibre Superloop Network card FLASH memory.
- Data containing the Fibre Superloop Network card identification and version is stored in the EEPROM.

CPU to MPU bus interface

Information exchange between the Meridian 1 CPU and the Fibre Superloop Network MPU is performed with packetized messages transmitted over the CPU bus.

This interface uses shared static random access memory (SRAM) as a communication exchange point between the CPU and the MPU. Both the CPU and the MPU can access this memory over the transmit and receive channels on the CPU bus.

Network bus interface

The network bus interface performs two major functions:

- Converts bit interleaved serial data received from the network bus into byte interleaved data for transmission over the 128 time slots used by the IVD bus
- Accepts byte interleaved data transmitted from the IVD bus and converts it into a bit interleaved data stream for transmission over the network bus

Fibre-optic interface

Two NT1P63 Electro-optical packlets can be installed on each Fibre Superloop Network card to provide redundant fibre-optic interfaces, or the Fibre Superloop Network card can be equipped with only one Electro-optical packlet for a nonredundant link. The fibre-optic interface provides a 155.52 Mbps point-to-point transmission facility.

The fibre-optic interface performs the following functions:

- Connects Meridian 1 to Remote IPE using a dedicated single mode fibre-optic link
- Provides a synchronous communication channel between the Fibre Superloop Network card MPU and the Fibre Peripheral Controller card MPU
- Uses one or, optionally, two Electro-optical packlets installed on the Fibre Superloop Network card to provide redundant fibre-optic links
- Uses buffers and transceivers to extend the MPU data, address, and control buses to the Electro-optical packlet

- Provides Electro-optical packet version identification, which is stored in the packet's EEPROM
- Monitors transmission quality of the fibre-optic link; if the transmission is degraded or fails, the Fibre Superloop Network card automatically transfers to the redundant link, if equipped.

Fibre Peripheral Controller card

The NT1P62 Fibre Peripheral Controller card is a microprocessor controlled peripheral interface between the Fibre Superloop Network card and the Remote IPE line cards. To communicate with the Fibre Superloop Network card, the Fibre Peripheral Controller card uses the Electro-optical interface and the fibre-optic link. To communicate with the peripheral equipment, the Fibre Peripheral Controller uses 16 full duplex serial loops, one for each line card in the IPE Module.

The Fibre Peripheral Controller card occupies one card slot in the IPE Module. The adjacent card slot is not the full width and must remain empty; however, a dummy faceplate should be installed in this empty card slot to provide a better air flow between cards. This is necessary because a non-fibre Peripheral Controller card occupies two card slots in the IPE Module and the Fibre Peripheral Controller card that plugs into the same card slot occupies only one card slot. The dummy faceplate is used in the floor-standing IPE Module but is not necessary in the wall-mounted IPE cabinet.

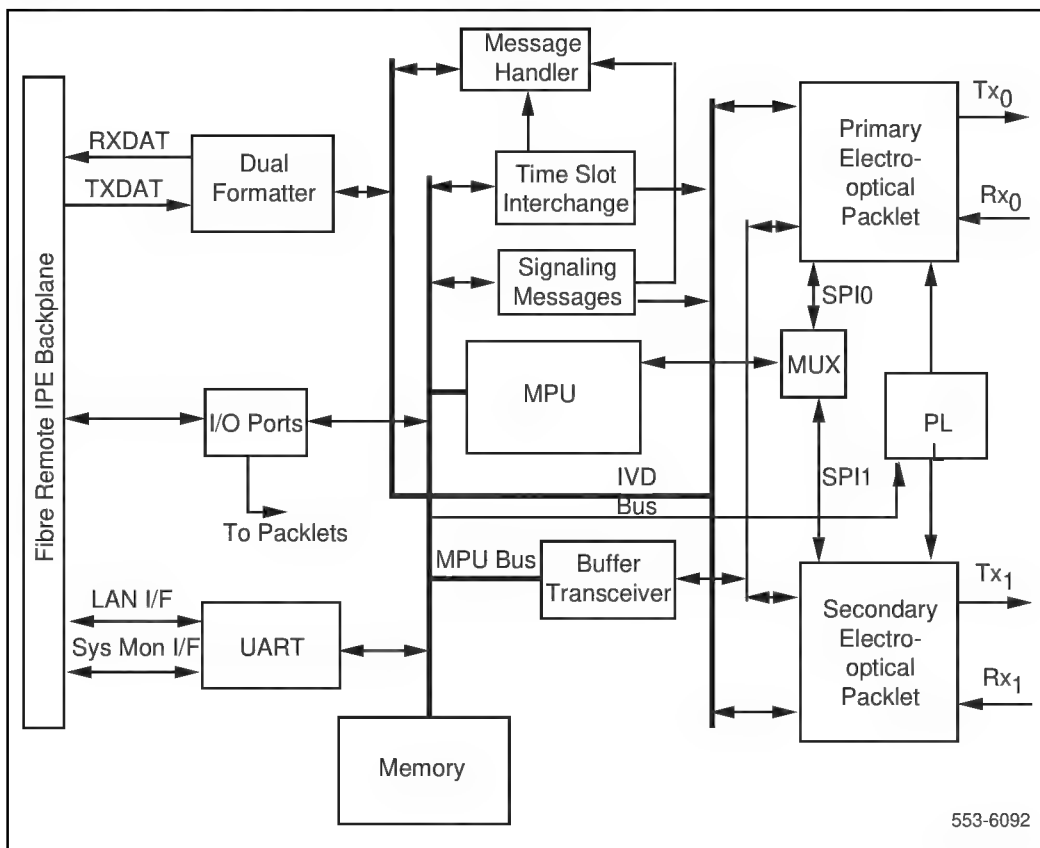
The main Fibre Peripheral Controller card performs the following functions:

- Provides a single or redundant dedicated optical link to connect the Remote IPE to Meridian 1
- Assigns any of the 120 time slots on the fibre-optic link to any time slot of the 16 full duplex serial loops assigned to line cards in the IPE Module
- Converts the SSD-type signaling format received from the Fibre Superloop Network card to the signaling format for digital telephone sets, and from digital telephone sets format to SSD-type format
- Polls telephone sets to determine the set type and its signaling protocol and transmits this information to the Fibre Superloop Network card
- Supports CCS protocol between the Fibre Superloop Network and the Fibre Peripheral Controller cards
- Provides an interface for a maintenance port

- Provides a Card-LAN port
- Provides continuity test and line card polling, enabling, and disabling
- Provides an interface for system power and alarm monitoring
- Performs diagnostic self-tests during power-up and when requested by the CPU

Figure 7 shows the block diagram of the Fibre Peripheral Controller card which illustrates major functional blocks. Functions of these blocks are described below.

Figure 7
Fibre Peripheral Controller card functional block diagram



Micro Processing Unit (MPU)

The MPU coordinates and controls data transfer and the addressing of peripheral devices and communicates with the Fibre Superloop Network card using serial communication channels. In addition, the MPU has a special communication channel used to communicate with the microcontroller on one Electro-optical packet at a time. The tasks the MPU performs depend on the interrupts it receives. These interrupts are prioritized by the importance of tasks they control.

The MPU is highly integrated and provides most of the decision-making logic on the chip. Functions on the MPU include controllers, timers, control logic, address decoding, dual port RAM and independent direct memory access, parallel input/output ports, and three independent full duplex serial communication channels that support various protocols.

The MPU can be reset by:

- powering up the Fibre Peripheral Controller card
- the watchdog timer

Memory

The Fibre Peripheral Controller memory stores programs and data for the following functions in the following locations:

- Boot code and self-test code are stored in the EPROM.
- Data is stored in the RAM.
- The main MPU function code is stored in the Fibre Peripheral Controller card FLASH memory.
- Data containing the Fibre Peripheral Controller card identification and version is stored in the EEPROM.

Card-LAN interface

To implement the Card-LAN interface, the Fibre Peripheral Controller card uses a dual UART device. One UART channel provides a serial communication interface to IPE cards.

The Card-LAN is a 19.2 kbps asynchronous interface. It is used to poll and communicate with IPE cards through the Fibre Peripheral Controller to transmit maintenance messages, which include:

- LED control of the IPE card enable/disable
- peripheral card configuration
- peripheral card type and version information

IPE interface

The IPE interface links IPE cards to the Fibre Peripheral Controller MPU using sixteen DS-30X loops, one for each IPE card. It contains the following Fibre Peripheral Controller circuits:

- Dual formatter that transforms serial peripheral loop information into parallel Integrated Voice and Data (IVD) bus information and parallel IVD bus information to serial peripheral loop information.
- Message handler that performs channel associated signaling to and from the IPE cards. It receives signaling information from the IPE cards, and then the MPU accesses this information, interprets it, and sends it to the Fibre Superloop Network in the appropriate format. From the Fibre Superloop Network, the signaling messages are received and interpreted by the Fibre Peripheral Controller MPU and sent to the serial peripheral loops in the appropriate format.
- Time slot interchange that provides the correspondence between the 120 voice and data time slots on the fibre-optic link and the 640 time slots on the IVD bus. The time slots on the IVD bus correspond directly to the peripheral line card loops.
- Common channel signaling that handles the SSD signaling to and from the Fibre Superloop Network card. It receives signaling packets from Fibre Superloop Network, checks for CRC errors, strips start/stop bits and sends the rest of data to the Fibre Peripheral Controller MPU for processing. It also processes the signaling information in the opposite direction by receiving the messages from the MPU, adds CRC and start/stop bits, and transmits these as SSD messages to the Fibre Superloop Network over the fibre-optic link.

Fibre-optic interface

Two NT1P63 Electro-optical packlets can be installed on each Fibre Peripheral Controller card to provide redundant fibre-optic interfaces. The Fibre Peripheral Controller card can be equipped with only one Electro-optical packlet for a nonredundant link operation. The fibre-optic interface provides a 155.52 Mbps point-to-point transmission facility.

The fibre-optic interface performs the following functions:

- Connects Meridian 1 to Remote IPE using a dedicated single mode fibre-optic link
- Provides a synchronous communication channel between the Fibre Superloop Network card MPU and the Fibre Peripheral Controller card MPU
- Uses buffers and transceivers to extend the MPU data, address, and control buses to the Electro-optical packlet
- Uses one or, optionally, two Electro-optical packlets installed on the Fibre Peripheral Controller card to provide redundant fibre-optic links
- Provides Electro-optical packlet version identification, which is stored in the packlet's EEPROM
- Monitors transmission quality of the fibre-optic link; if the transmission is degraded or fails, the Fibre Peripheral Controller card automatically transfers to the redundant link, if equipped

Engineering guidelines

Meridian 1 general system engineering guidelines are described in *Meridian 1 system engineering* (553-3001-151). The following information deals specifically with engineering guidelines for the Fibre Remote IPE planning and implementation. It also describes the fibre-optic interface specifications and fibre-optic link characteristics.

Fibre Remote IPE capacity

Meridian 1 physical capacity depends on the system's configuration and size. System options 21E, 51, 51C, 61, 61C, 71, 81, and 81C are designed to provide port capacities from tens to thousands of ports. These ports are normally local to Meridian 1, however, by implementing Fibre Remote IPE, some of these ports can be located at one or more remote sites.

The overall system capacity does not change by installing Fibre Remote IPE. The difference between the Meridian 1 system with Fibre Remote IPE and without Fibre Remote IPE is the distribution of the line cards, that is, the subscriber loops. Fibre Remote IPE allows you to distribute the peripheral equipment at long distances from Meridian 1 and provide the same functions and features to remote subscribers as to local subscribers.

Note: System capacity may be affected by the capacity of the Fibre Superloop Network card, which supports only one IPE Module instead of the two IPE Modules supported by the Superloop Network card.

The Fibre Remote IPE capacity can be tailored according to port capacity requirements at the remote site. When planning a Fibre Remote IPE site, you must determine the number of IPE cards required to support the existing and future traffic needs. Based on these requirements, two Fibre Remote IPE hardware options are available:

- Floor-standing Remote IPE column
- Wall-mounted Remote IPE cabinet

Floor-standing Fibre Remote IPE

The floor-standing Fibre Remote IPE consists of the Meridian 1 pedestal, IPE Module, and a top cap. One IPE Module supports up to 16 line cards, or 256 ports if each line card has 16 ports. If more ports are required, additional IPE Modules can be added to the column. A column contains a maximum of four modules. Each IPE Module requires one Fibre Peripheral Controller card located in the IPE Module and a corresponding Fibre Superloop Network card located in a Meridian 1 network card slot.

Note: In a Meridian 1 column, a Superloop Network card can support up to two IPE Modules. However, in a Meridian 1 system with the Fibre Remote IPE configuration, a Fibre Superloop Network card supports only one Remote IPE Module. This is due to the dedicated fibre-optic link configuration between the Fibre Superloop Network card and the Fibre Peripheral Controller card. Since fibre-optic links are dedicated, they cannot be shared between two different IPE Modules at the remote site.

Wall-mounted Fibre Remote IPE

The wall-mounted Fibre Remote IPE consists of NT1P70 main and NTAK12 expansion cabinets. The main cabinet supports the Fibre Peripheral Controller card and up to 10 IPE cards or 160 ports. If more ports are required, an expansion cabinet can be installed adjacent to the main cabinet.

These two cabinets are linked with an inter-cabinet cable that plugs into P1 50-pin connectors located at the bottom left-hand corner of each cabinet. This cable extends six peripheral bus DS-30X loops to the first six IPE card slots in the expansion cabinet. One Fibre Peripheral Controller card located in the main cabinet supports cards in both main and expansion cabinets as long as the expansion cabinet contains no more than 6 IPE cards installed in the first six IPE card slots.

Engineering the fibre-optic link

A fibre-optic link can be constructed using single-mode or multi-mode fibre-optic cables. The type of fibres you select will depend on various factors:

- distance between Meridian 1 and the Fibre Remote IPE site
- possible existence of a fibre-optic link you wish to use for this application
- cost, availability, and so on

When engineering a fibre-optic link, you must consult the component manufacturer's data sheets to determine whether the cable, connectors, and other components meet the transmission characteristics and the signal loss plan for the transmission distance required for your specific Fibre Remote IPE application.

Fibre-optic bandwidth

When using a single-mode fibre, the optical link transmission distance is strictly loss-limited and not dispersion limited. When using multi-mode fibre, the transmission distance will be loss and dispersion limited. Appropriate calculations must be made to determine the maximum link distance. The data rate over the multi-mode fibre is limited by the optical bandwidth of this multi-mode fibre. The bandwidth is defined as the frequency at which a sinusoidal signal is attenuated by 3 dB relative to a DC signal.

For the Fibre Remote IPE, the bandwidth is defined to be 1310 nanometers. The bandwidth-length product for single-mode is 5 GHz km and for the graded index multi-mode is 800 MHz km.

When you engineer a fibre-optic link, you must make sure that the total signal attenuation between the Fibre Superloop Network and the Fibre Peripheral Controller Electro-optical interfaces does not exceed 13 dB loss.

Note: If the fibre-optic link already exists, check the link's characteristics and end-to-end loss to determine if it can support a Fibre Remote IPE and, if it can, at what distance between Meridian 1 and the Fibre Remote IPE.

Bandwidth engineering rules

The eye closure due to dispersion must not exceed 0.5 dB to ensure reliable operation of the Electro-optical packlets. Based on this, the normalized bandwidth (B_N) must not be less than 0.71.

The maximum fibre length for a link can be calculated by the following equation, where L is the fibre-optic link length, B_L is the bandwidth-length product, B_T is the NRZ bit rate of 155.52 MHz, and B_N is the maximum allowable optical bandwidth of 0.71 when normalized to the above bit rate.

$$L = \frac{B_L}{B_T \times B_N}$$

To engineer a multi-mode fibre link, use the following steps:

- 1** Obtain bandwidth-length product of the fibre from the manufacturers' data sheet.
- 2** Calculate the maximum link length using the above equation.
- 3** Measure the eye closure of the fibre. When measured at 155.52 MHz and 1310 nanometers it should be less than 0.5 dB.
- 4** Measure the attenuation of the fibre link. When measured at 1310 nanometers the attenuation should not exceed 10 dB.

Example: A maximum link length of a multi-mode fibre link with bandwidth-length product of 500MHz km would be:

$$L = \frac{500\text{MHzkm}}{155.52\text{MHz} \times 0.71} = 4.53\text{km}$$

This multi-mode fibre link should not exceed 4.53 kilometers in length. A 3 dB safety margin should be allowed when engineering a multi-mode link to compensate for additional attenuation as a result of core size variations in fibers. The single-mode fibre core size varies between 8 and 9 microns and the multi-mode fibre core size varies between 50 and 62.5 microns.

Fibre-optic interface specification

When planning a fibre-optic link, you must consider the transmit and receive signal power and the signal attenuation of each component in the link to determine total signal attenuation.

Table 1 shows the transmit and receive signal power level at the signal source and the signal destination. In the table, for simplicity use **FXNET** for Fibre Superloop Network and **FXPEC** for Fibre Peripheral Controller cards. The receive circuit on the Electro-optical packet must be able to detect a signal at a level as low as -28 dBm.

Table 1
Fibre-optic transmit and receive signal levels

Signal source	Transmitted power		Received power	
	Min	Max	Min	Max
FXNET Card	-15 dBm	-8 dBm	-28 dBm	-8 dBm
FXPEC Card	-15 dBm	-8 dBm	-28 dBm	-8 dBm

Fibre-optic link loss characteristics

The fiber-optic link components add to the total end-to-end link signal attenuation. The fibre-optic cable attenuation depends on the type of cable selected. The manufacturer’s data sheet provides necessary parameter values, which must be considered when engineering the link. In addition, the signal attenuation is also affected by the number of splices in the link and the signal loss in the link terminating the fibre-optic connectors.

Table 2 shows an example of different fibre-optic link components and the total signal attenuation for a 10 km link of 11.2 dB.

Table 2
Example of fibre-optic link components and their attenuation factors

Component	Quantity	Attenuation in (dB)	Total attenuation in (dB)
Fibre (10 km)	1	0.6/km	6.0
Splices	10	0.2/splice	2.0
FC/PC Connectors	4	0.8/connector	3.2

Maximum calculated signal attenuation across the link is 12 dB, which allows 1dB safety margin.

Note: Actual attenuation must be determined from specific manufacturer's data sheets for each link component.

Fibre-optic cable handling considerations

Fibre-optic cable selection, installation, and routing require special considerations. Splices and connector contacts represent discontinuities that contribute to the attenuation of the signal as it propagates through the link.

Routing the fibre-optic cable must be considered with care. The most critical routing areas are tight spots where the cable must be bent. When bending a cable you must make sure that the minimum bending radius of 1.4 inches (3.5 cm) is not exceeded. If the cable is bent tighter than the minimum radius, the attenuation increases and the cable may break or become damaged.

Before you start routing and splicing fibre-optic cables, read the cable specification sheet and adhere to the specified installation rules. When handling optical fibres, follow the safety recommendations at all times. Keep all connectors capped while the cables are disconnected.

WARNING

When handling optical fibers, follow the recommended safety procedures at all times.

Before you can handle optical fibres, you must take necessary training and become certified in working with fibre-optic cables.

Cable types and their terminations

Single-mode fibres and fibre-optic connectors allow only one path for light to propagate because of the small diameter of the fibre. These are used for high speed transmission and longer transmission distances. Multi-mode fibres and fibre-optic connectors allow more than one mode of propagation for a specific wavelength. These cause dispersion of light and limit the effective bandwidth and distance of communication. For the Fibre Remote IPE, Northern Telecom recommends single-mode fibre-optic cables.

If a multi-mode fibre-optic link already exists, it must be evaluated to determine if it will support the Fibre Remote IPE application and, if it will, at what distance from Meridian 1. The distance of the link can be determined by finding a point of the fibre-optic link where the signal loss is less than 13 dB for a given transmission rate.

To evaluate an existing link, contact your Northern Telecom distributor to learn the method and instrumentation required to test the link's suitability for the Fibre Remote IPE application.

A fibre-optic link may be composed of single-mode or multi-mode fibres, splices, and fibre-optic connectors. In a floor-standing Fibre Remote IPE, the fibre-optic link terminates at the optical I/O panel FC/PC fibre-optic connectors. In a wall-mounted Fibre Remote IPE cabinet, the fibre-optic link terminates at the fibre management frame and continues from the fibre management frame to the Electro-optical packet FC/PC fibre-optic connectors installed on the Fibre Peripheral Controller card. In both cases, FC/PC fibre-optic connectors have to be installed onto fibres of the link so that the link can be directly connected to the FC/PC fibre-optic connectors of the Fibre Remote IPE.

System planning and ordering

Meridian 1 provides the user with a variety of system sizes and features. To select a system that will best suit your current and future communication needs, you must plan carefully. Contact your Northern Telecom representative or your Northern Telecom distributor to help you plan the system.

If you are installing a new Meridian 1 with Fibre Remote IPE, refer to *Meridian 1 installation planning* (553-3001-120) and *Meridian 1 system engineering* (553-3001-151) for overall system information. To obtain specific planning and ordering information for the fibre-optic link and network and peripheral cards interfacing with this link, follow the information below.

If you have an existing fibre-optic link, you must evaluate it to determine if the link characteristics such as loss, fibre-optic mode, and so on, can support a Fibre Remote IPE. You also must evaluate the distance between Meridian 1 and the Fibre Remote IPE—the link loss should not exceed 13 dBs.

System selection

Determine the type of Fibre Remote IPE enclosure. This selection may be dictated by the installation preference, blocking considerations, and the number of IPE cards required at the remote site.

If you plan a floor-standing system, you must select the Meridian 1 modular column. If you plan a wall-mounted system, you must select the cabinet.

In some applications where non-blocking or low blocking traffic considerations are important, you have to limit the number of peripheral cards supported by each Fibre Peripheral Controller card. For a non-blocking condition, the 120 voice/data time slots will support seven or eight 16-port line cards. Each additional line card in the IPE Module or the wall-mounted cabinet increases call blocking under high traffic conditions. Refer to *Meridian 1 system engineering* (553-3001-151) to calculate traffic.

The system type may also be dictated by the number of ports required at the remote site. The modular column configuration supports 16 line cards and provides a maximum of 256 ports. This column may be expanded by adding a second IPE Module to support an additional 256 ports. Each IPE Module requires a Fibre Peripheral Controller card at the remote site and a corresponding Fibre Superloop Network card at the local Meridian 1 site.

In addition to line cards, the Fibre Remote IPE supports all the cards that do not require external connection to Meridian 1 common or network equipment.

The wall-mounted configuration supports 10 line cards. You may want to select the wall-mounted system if your system size requirement is less than ten IPE cards. To expand this type of system beyond 10 IPE cards, you must add an expansion cabinet adjacent to the main cabinet and install up to six IPE cards into the first six IPE card slots of the expansion cabinet.

Fibre Remote IPE site planning

When you select a site for your Fibre Remote IPE, you must consider the number of ports currently required at the site and the possibility of expansion to meet future needs. You also must consider environmental, power, and cable routing requirements.

Environmental requirements

Fibre Remote IPE equipment conforms to the same environmental requirements as the rest of the Meridian 1 equipment. Temperature, humidity, and altitude for Meridian 1 equipment operation should not exceed the specifications shown in Table 3.

Table 3 shows the operating and storage environmental specifications. Ideally Meridian 1 equipment should operate in a stable environment at 22° C (72° F); however, the system is designed to operate in the temperature and humidity ranges specified in the table.

Table 3
Environmental requirements

Condition	Environmental specifications
Operating	
Temperature	0° to 60° C (32° to 140° F)
Relative humidity	5% to 95% noncondensing
Altitude	3,048 meters (10,000 feet) max
Storage	
Temperature	−50° to 70° C (−58° to 158° F)
Relative humidity	5% to 95% noncondensing

Power requirements

At the remote site, cards in the IPE Module are powered by the power supply installed on the left-hand side of the IPE Module. The power consumption of the Fibre Peripheral Controller card is not significantly different from the power consumption of the standard Peripheral Controller card. This allows the standard IPE Module's power supply to be used in Fibre Remote IPE.

Similarly, the wall-mounted cabinet power supply, which is installed in the left-hand side of the cabinet shelf, provides power to the Fibre Peripheral Controller card and up to 10 IPE cards. The expansion cabinet requires its own power supply to provide power to an additional six IPE cards.

Table 4 shows the power supply DC output voltages and the current they supply to the Fibre Superloop Network and Fibre Peripheral Controller cards in a redundant and nonredundant fibre-optic link configuration. It also shows the corresponding total power consumption for each card.

Table 4
FXNET and FXPEC with single and dual Electro-optical packets power requirements

Voltage source in VDC	Nonredundant link		Redundant link	
	FXNET card	FXPEC card	FXNET card	FXPEC card
+5 V	2100 mA	1700 mA	2300 mA	1900 mA
−4.5 V	650 mA	650 mA	1300 mA	1300 mA
+15 V		50 mA		50 mA
−15 V		50 mA		50 mA
+12 V	50 mA		50 mA	
−12 V	50 mA		50 mA	
Total Power	14.6 W	13 W	20 W	18.5 W

Fibre-optic cable requirements

A fibre-optic link may be composed of single-mode or multi-mode fibres, splices, and fibre-optic connectors. In a floor-standing Fibre Remote IPE, the fibre-optic link terminates the optical I/O panel FC/PC fibre-optic connectors. In a wall-mounted Fibre Remote IPE cabinet at the fibre-optic link terminates at the a fibre management frame and continues from the fibre management frame to the Electro-optical packlet FC/PC fibre-optic connectors installed on the Fibre Peripheral Controller card. In both cases, FC/PC fibre-optic connectors have to be installed onto fibres of the link so that the link can be directly connected to the FC/PC fibre-optic connectors of the Fibre Remote IPE.

Note: Single-mode fibres and fibre-optic connectors allow only one path for light to propagate because of the small diameter of the fibre. These are used for high speed transmission and longer distances. Multi-mode fibres and fibre-optic connectors allow more than one mode of propagation for a specific wavelength. These cause dispersion of light and limit the effective bandwidth and distance of communication. For the Fibre Remote IPE, Northern Telecom recommends single-mode fibre-optic cables.

To connect the Electro-optical packlet from the Fibre Superloop Network and Fibre Peripheral Controller card faceplate to the optical I/O panel, two optical patchcords are used. For a redundant configuration, four optical patchcords are used, two for transmit sides and two for receive sides.

Electro-optical equipment planning form—example

Table 5 shows a sample planning form. It lists components required to construct a fibre-optic link.

Table 5
Example of the planning form for a wall-mounted Fiber Remote IPE

Item	Part Number	Quantity at Meridian 1	Quantity at Remote IPE
FXNET card		1	
FXPEC card			1
EOI packlet		1 or optionally 2	1 or optionally 2
EOI packlet blank		1 for a non-redundant link	1 for a non-redundant link
I/O panel		1	1
I/O to faceplate cords		2	2
FP/CP connectors		2	2
Fibre-optic cable (if 1 km lengths)			10 (10 km link)
Splicing			

Electro-optical equipment planning form

Enter the part number and the quantity for each item required at Meridian 1, for the fibre-optic link, and at the Fibre Remote IPE.

Table 6
Ordering form

Item	Part Number	Quantity at Meridian 1	Quantity at Remote IPE